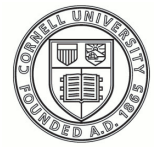

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An Empirical Analysis of Risk, Incentives, and the Delegation of Worker Authority

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Abstract

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Keywords

Agency Theory, Risk versus Incentives Tradeoff, Delegation of Worker Authority, Performance Pay

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Abstract

The notion of a negative relationship between risk and incentives is a central prediction of agency theory. A vast literature has failed to find consistent empirical support for this prediction, with some studies finding a positive relationship, some a negative relationship, and some no relationship at all. Prendergast's (2002) theory extends the principal-agent model to incorporate the delegation of worker authority, showing that a positive relationship between risk and incentives can arise and potentially explaining the mixed results from empirical tests. In this paper, we empirically test Prendergast's theory. Using a large, nationally-representative cross section of British establishments that includes information both from employers and from multiple workers in each establishment, we address four empirical questions: 1) Is there evidence of a risk-incentives tradeoff as predicted by the principal-agent model? 2) Is there evidence of a positive relationship between incentive pay and the delegation of worker authority as assumed by Prendergast? 3) Is there evidence of a positive relationship between risk and authority as Prendergast also assumes? 4) Is there empirical support for the main testable implication of Prendergast's model, namely that the evidence favoring a risk-incentives tradeoff should strengthen when authority controls are added to the model? Our answers are affirmative for all four questions.

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I. INTRODUCTION

The notion of a tradeoff between risk and incentives is a key implication of the principal-agent model that has received significant attention in the literature since the original papers by Holmstrom (1979) and Shavell (1979). The intuition is that risk-averse workers are loathe to accept output-contingent compensation contracts in production settings characterized by a high degree of risk, meaning situations in which output is determined largely by stochastic factors beyond the worker's control. The firm's response, therefore, is to decrease the amount of output-based pay as the degree of risk or uncertainty in the production environment increases. This theoretical prediction has been the subject of numerous empirical tests, and the collective evidence has been inconclusive. As seen in the last column of Table 1, some tests have found the predicted negative relationship, while others have found a positive relationship or no relationship.

Prendergast (2002) proposes a theory that potentially explains the inconclusive empirical evidence. At the heart of Prendergast's explanation is the delegation of worker authority which, he argues, is a key element that the standard agency model ignores. In production settings characterized by a low level of uncertainty, the firm has a clear sense of what tasks should be performed and how they should be performed. In such settings, the firm is content to monitor labor inputs. In contrast, when the production setting is characterized by a high level of uncertainty, the firm understands less what decisions need to be made and which tasks should be performed. The firm responds by delegating more authority to the worker, who is closer to the production process and often has better information than does the firm about what tasks should be performed. The firm accompanies this delegation of authority with output-based pay, to hold the worker

accountable for his decisions and to ensure that the worker does not misuse his discretion by choosing the wrong tasks. That is, when the degree of uncertainty increases, the firm shifts from monitoring inputs and retaining control over tasks to monitoring outputs and delegating authority over tasks.

This suggests a positive relationship between incentive pay and risk (operating through the channel of worker authority), in contrast to the negative relationship (operating through the channel of insurance) implied by standard agency theory. Thus, the main testable result of Prendergast's model is that the predicted sign of the relationship between risk and incentives is ambiguous. He states the empirical problem as follows:

"The empirical difficulty here is that worker discretion is typically unobserved that could bias econometric estimates … without controlling for some measure of responsibility, we are likely to find a positive relationship between uncertainty and incentives; but if we can control for task assignment, we would expect to see no such relationship." (pp. 1096-1097)

Thus, Prendergast argues that controlling for worker authority in a regression of incentive pay on risk should decrease the coefficient of risk. A potential problem with conducting the empirical test in this way is that the degree of worker authority is endogenous, since it is chosen by the employer along with the structure of the compensation plan. Since the unobserved determinants of both choices are likely to be correlated, if a regression of incentive pay on risk includes authority controls the estimated coefficients will be biased. The correct empirical model must treat the degree of worker authority as endogenous.

Prendergast cites several empirical papers that provide indirect support for his theory, but a direct test requires that worker authority be incorporated into the standard risk-incentives regressions. A practical difficulty with implementing this test is that

measures of worker authority over task selection are rarely available in existing data sets. Furthermore, measures of worker authority must be available in conjunction with measures of incentive pay and risk for the theory to be tested. Our empirical tests are based on a large, nationally-representative cross section of British establishments from the 1998 Workplace Employee Relations Survey (WERS98), containing information on risk, multiple dimensions of worker authority (both as perceived by workers and as perceived by employers), and incentive pay.

We address four empirical questions in this paper. Is there empirical support for:

1) the risk-incentives tradeoff predicted by agency theory?
2) Prendergast's assumption that authority and incentives are positively related?
3) Prendergast's assumption that risk and authority are positively related?
4) the main testable implication of Prendergast's model, namely that empirical support for the risk-incentives tradeoff predicted by agency theory should strengthen when authority is incorporated into a risk-incentives regression model?

II. THEORETICAL BACKGROUND AND PREVIOUS LITERATURE

In Prendergast's model, the agent is assumed to be risk neutral (to remove the standard risk-incentives tradeoff and focus purely on delegation) and exerts effort on one of n possible tasks. The principal chooses the compensation contract (either input-based or output-based) and either assigns the agent a task or grants the agent discretion over which task to choose. In contrast to the traditional approach in agency theory that treats uncertainty in the economic environment as synonymous with measurement error arising from the principal's inability to observe the agent's effort perfectly (e.g. Holmstrom and

Milgrom (1987, 1991)), Prendergast distinguishes between these two concepts and defines risk only as environmental uncertainty. Performance of the firm is given by $y_i = e_i + \varepsilon_i$ where i denotes the agent's task. The n random variables ε_i have common variance, σ^2, but differ in their means. An increase in σ^2 implies a more uncertain production environment.

An important underlying assumption is asymmetric information about the outcome of the environmental uncertainty (the agent knows the true value of ε_i whereas the principal only knows its distribution), and this asymmetry justifies the delegation of authority. The idea is that the worker frequently has more accurate information than does the manager about the idiosyncrasies of the production process. For example, a line worker is more likely to know whether the particular machine he operates is about to break down and lead to a production bottleneck (i.e., supply variability) than the plant manager. Likewise, a sales clerk would be better informed concerning customers' impressions about a new product (i.e., demand variability) than would be the store manager. Even when there is a considerable flow of information from worker to manager, the worker frequently has an informational advantage by virtue of being closer to the production process.[1] Moreover, this informational advantage is likely to become more pronounced when the variance in output is large.

Prendergast shows that when σ^2 is sufficiently low the principal assigns the agent a task and compensates using an input-based contract, whereas when σ^2 is sufficiently

[1] The argument that the agent should receive more authority the greater is his informational advantage was formalized by Aoki (1986). Jensen and Meckling (1992) analyze how the decentralization of decision rights to agents with specific knowledge and abilities increases efficiency and explain that these decision rights should be accompanied by a control mechanism such as pay-for-performance in order to motivate individuals to use their decision rights optimally. See also Dessein (2002) for a discussion of recent trends in firms pushing decision rights lower in their organizational hierarchies in order to profit from the local knowledge possessed by lower level managers. Since the 1990s, many firms have been decentralizing decision rights, including AT&T, General Electric, Motorola and Ford.

high the principal allows the agent to choose the task but compensates using an output-based contract. The result arises because Prendergast assumes that the agent is risk-neutral. If agents are risk-averse, the usual risk-incentives tradeoff from the standard agency model is also present, so that the net effect of risk on incentives is ambiguous in sign.

Our focus in this paper is on testing Prendergast's proposed theoretical explanation for the mixed empirical support for the risk-incentives tradeoff that is documented in Table 1. Our data are particularly well suited for testing Prendergast's model, given the availability of an authority measure that closely matches the notion of authority discussed by Prendergast. While his model is one of the earliest and probably the best known in this literature, alternative theoretical approaches for explaining the empirical puzzle have been proposed (e.g., Zabojnik 1996, Core and Qian 2002, Baker and Jorgensen 2003, Raith 2003, Oyer 2004, Adams 2005, Raith 2005, Serfes 2005, Shi 2005). Many of these alternative theories do not concern issues of delegation of authority and, more importantly, some of them are based on ideas that our data are ill-equipped to address (e.g. distinguishing between alternative types of risk), so we do not address them in this paper. However, we see these alternative theories as important areas for future research, and we also stress that support for Prendergast's model, as we find in this paper, in no way casts doubt on the validity of these alternative theories. In the remainder of this section, we briefly survey the alternative theories. [2]

Rather than focusing on delegation of authority, Zabojnik (1996) and Baker and Jorgenson (2003) emphasize a distinction between two different types of risk. One type

[2] It is also possible, of course, that there are factors other than those considered in these theories which are correlated with delegation, such as skill, pay, or how crucial the worker's role is within the firm, that are the true source of the positive relationship between risk and incentives.

reflects the uncertainty afflicting both the principal and the agent symmetrically modeled in the standard principal-agent model. The other type reflects uncertainty that is resolved (for the agent but not the principal) before the agent chooses an action. Even with risk-averse agents the slope of the optimal linear incentive contract may be increasing as the amount of the second type of risk in the production environment increases. One appealing feature of this alternative approach is that, since it does not involve issues of delegation, it provides a more natural explanation than Prendergast's for thinking about the relationship between risk and CEO incentives, since there is likely to be little variation in the amount of delegation to the CEO from the board. Another appealing feature of this approach is that it predicts the simultaneous use of both input-based and output-based pay, whereas Prendergast's model (taken literally) implies that compensation is either entirely input-based or entirely output-based. Unfortunately, we are unable to address the predictions of these models using the WERS data, since we cannot distinguish empirically between the two different types of risk.

Raith (2003) combines a principal-agent model with a model of oligopolistic price competition among firms, and shows that the presence of competition among firms can lead to a positive relationship between the variance in firm profits and incentive pay. The idea is that there is a positive relationship between market competition and variance of firm profits, and a positive relationship between competition and incentive provision to induce workers to find ways to cut firm costs. It would be possible to address Raith's (2003) model using the WERS98, and that would be a useful objective for future work.

Oyer (2004) distinguishes between two types of volatility: variance of shocks common to all firms, and variance of the profits of the individual firm (idiosyncratic

volatility). His model predicts that a greater common shock variance or a less volatile idiosyncratic shock increases the difficulty of replacing workers, making the adoption of incentive pay more likely. To the extent that this notion of the degree of difficulty to replace workers complements delegation of authority, our results are consistent with Oyer's prediction of a positive relationship between common shock variance and incentives.

Shi's (2005) model focuses on a particular type of agent who has already been delegated authority, the CEO. When there is uncertainty about the state of the world to which the CEO has the ability to respond, the CEO can exert effort to collect information about the state of the world in order to make the correct decisions, which the board of directors promotes using incentive pay to the CEO. This gives rise to a positive relationship between risk and incentives. In essence, Shi's model is quite similar to Prendergast's (2002) except that "authority" is replaced with "ability to respond to risk". While Shi has CEOs in mind, Prendergast's (2002) model applies to workers more generally, and given that the WERS98 represents workers from many different occupations, we find it better suited to test Prendergast's (2002) theory.

Serfes (2005) introduces into the standard agency model endogenous matching between the principal and the agent and shows that a positive relationship between risk and incentives may arise when agents with high degrees of risk aversion are matched with low risk principals: an increase in risk attracts an agent with lower risk aversion, which puts upward pressure on incentives. We cannot address this model empirically, since the WERS98 lacks information on a worker's degree of risk aversion.

Core and Qian (2002) propose an agency model in which the agent must be motivated to expend two types of effort: productive effort required for working on the firm's existing projects, and evaluation effort required to gauge the profitability of new and possibly risky projects. When there is greater uncertainty about the success of new projects, the firm increases its use of incentive pay to encourage the worker to choose optimally. The notion of project selection by agents can be interpreted as delegation of decision-making authority to agents: the agent evaluates a new project and then must decide whether to accept or reject it. The agent uses his private information and discretion here. However, unlike Prendergast (2002), Core and Qian never consider the alternative situation in which the principal does not delegate project selection rights to the manager (i.e. the situation in which the principal himself makes the decision of whether to accept or reject a new project). Core and Qian are motivated by incentive provision to CEOs, which explains why they focus on motivating the manager to choose the correct (productive) projects despite the risk involved, and neglect the presence vs. absence of that decision right in the first place. Testing Core and Qian's theory would require one to distinguish what proportion of a worker's pay-for-performance is based on the agent's effort on the firm's existing projects and his effort on the evaluation of new projects (or more generally to distinguish between worker actions that increase firm profits as opposed to worker actions that increase the volatility of firm profits), and unfortunately the WERS does not have a breakdown of tasks performed by workers.

The only alternative theories we are aware of which derive a positive relationship between risk and incentives while incorporating the delegation of worker authority are Adams (2005) and Raith (2005). In Adams' (2005) model, for workers with discretion

over task selection, the firm places greater value on incentive pay when it is difficult to monitor the worker's private information, and if uncertainty in the demand for the firm's product has a greater effect on the ability of the firm to monitor the worker's information than it does on firm profits, greater uncertainty is associated with greater use of incentive pay. We discuss the extent to which our results are consistent with Adams' (2005) later in our paper. In Raith's (2005) analysis, whether the relationship between risk and incentives is positive or negative depends on the source of uncertainty: the first source of uncertainty is noise in the principal's measure of the agent's output and leads to lower delegation and lower incentives, while the second source of uncertainty is the variance in the agents task productivities and implies higher delegation and higher incentives (this second prediction is similar to Prendergast's (2002) main result). Unfortunately, we are unable to fully address Raith's model using the WERS data because these data do not contain information on the extent of the first type of uncertainty, as well as a number of other key controls such as the quality of the agent's knowledge in Raith's model. However, the results in this paper are consistent with Raith's prediction of a positive relationship between the second type of uncertainty in his model and incentive pay.

III. DATA AND VARIABLE DEFINITIONS

Our sample is drawn from both the management and worker questionnaires in the 1998 British Workplace Employee Relations Survey (WERS98), jointly sponsored by the Department of Trade and Industry, ACAS, the Economic and Social Research Council, and the Policy Studies Institute. Distributed via the UK Data Archive, the WERS data are a nationally representative stratified random sample covering British workplaces with

at least ten employees, except for those in the following 1992 Standard Industrial Classification (SIC) divisions: agriculture, hunting, and forestry; fishing; mining and quarrying; private households with employed persons; and extra-territorial organizations. Some of the 3192 workplaces targeted were found to be out of scope, and the final sample size of 2191 implies a net response rate of 80.4% (Cully et al., 1999) after excluding the out-of-scope cases. Data were collected between October 1997 and June 1998 via face-to-face interviews. The respondent in the management questionnaire was usually the most senior manager at the workplace with responsibility for employment relations. In addition, a random sample of up to 25 workers per establishment was surveyed, producing the responses for the worker questionnaire.

Incentive Pay

In the principal-agent model, the firm consists of a single worker whose individual output (or net revenue) coincides with that of the firm. Taken literally, the model abstracts from some relevant details of the workplace, such as the fact that most firms are comprised of more than one worker, and a broader interpretation is therefore required if the theory is to be helpful in understanding behavior in a large sample of employers. In practice, employers rarely design incentive compensation systems tailored to the characteristics of individual workers. In the typical workplace, the employer designs the incentive pay system to apply to broad groups of workers (such as all workers within an establishment or perhaps all workers in a particular occupation within the establishment) rather than an individual worker. Thus, from the standpoint of empirical work that aims to test the theory, a measure of pay-for-performance at the level of the

establishment or perhaps a particular occupation within an establishment (as opposed to the level of the individual worker) is appropriate. We use the following measure:

Performance Pay = 1 if any workers at the establishment receive payments or dividends from individual or group performance-related schemes
= 0 otherwise[3,4]

In Appendix A we consider an alternative measure of performance pay, equaling 1 if any workers in the establishment's largest occupational group receive incentive pay, and 0 otherwise. An advantage of this alternative measure is that it requires that incentive pay be sufficiently prevalent in the establishment that it is used for a relatively large group of workers, if the establishment is to be classified as using incentive pay, and for that reason it might be argued that the measure is better than *Performance Pay*. At the same time, the risk measure we use is not specific to the establishment's largest occupational group, so we think the most conservative approach is to use *Performance Pay* to produce our main results. Nonetheless, using this alternative measure we find even stronger empirical support for the first and fourth questions we pose at the end of the Introduction than we find using *Performance Pay*. See Table A2 and the last two paragraphs of Appendix A.

[3] The wording of the question permits group-based as well as individual-based schemes, whereas the relevant theories pertain to individual-based schemes. This does not present a problem for our analysis. The majority of establishments reporting pay-for-performance use individual-based schemes in our data, and restricting the incentive pay measure to equal one only when it is certain that individual-based performance pay is used yields results very similar to those we report here (see Appendix A).

[4] In the principal-agent model the relevant notion of incentive pay is a linear piece rate, or fraction of the agent's compensation that is output based. In contrast, our binary measure of performance pay describes whether performance-related pay is used at all, providing no information on its intensity. This poses no problems for our analysis, since we have a large sample of establishments with plenty of variation in the use of incentive pay, though more detailed data on the fraction of compensation that is incentive-based within each establishment would be even more informative. We also note that, from the standpoint of testing Prendergast's specific model, our binary measure actually matches the theory better than would a measure of the fraction of pay within the establishment that is incentives-based. The reason is that the prediction of Prendergast's model (taken literally) is that the principal chooses either output-based pay or input-based pay and never a mix of the two.

Risk or Uncertainty

In the principal-agent model, the agent's output or net revenue (which equals the output or net revenue of the entire single-worker firm) is determined both by the agent's effort level and by a stochastic component. The variance of the stochastic component of output is referred to as risk or uncertainty. From the standpoint of empirical tests the relevant measure of risk is not stochastic variation in an individual worker's output but rather output variance at a broader level. For concreteness, consider the piece-rate system used to compensate the installers of automobile windshields at Safelite Glass Corporation. There are many random factors specific to an individual worker that affect the worker's output (for example, the worker's health or attitude on a given day, or whether the worker was kept awake all night by a barking dog). While in principle the individual output variability introduced by these factors could be used by Safelite to tailor a specific piece rate scheme to each worker, this is not what happens in practice. Instead, Safelite designs a "one size fits all" piece-rate scheme that is applied uniformly to all workers. Thus, it is not individual-specific risks that the firm insures workers against when designing the compensation system but rather broader market-level risks that are expected to influence the outputs of larger groups of workers. Our measure is as follows:

Risk = 1 if the current state of the market for the main product or service of the establishment is described as "turbulent"
= 0 otherwise

Assuming the size of the market faced by the establishment is closely tied to output, as is reasonable to expect in equilibrium, turbulence or uncertainty with respect to the size of the market reflects the concept of risk envisioned in agency theory.

One advantage our subjective risk measure offers and that is worth emphasizing is that, in contrast to the objective risk measures used in many of the studies summarized in Table 1, it is unlikely to be directly affected by employer behavior (and therefore endogenous).[5] For example, in the large body of work on executive pay, the risk measure is frequently variance in firm accounting returns, stock returns, operating profits, or sales, all of which are subject to CEO influence, and in the studies of sharecropped farms, the measures of risk include variance in farm profits, variance in crop yield per acre, and type of crop, all of which are subject to the farmer's influence.

Worker Authority

Prendergast (2002) draws a key "distinction between instances in which an employer tells his agent what to work on and situations in which the agent is given ***discretion over the activities that he spends time on***. [emphasis added]" (p. 1072) Prendergast's notion of authority therefore corresponds to delegating workers the power to make their own decisions about which tasks to perform.[6] The WERS worker survey contains a question that closely corresponds to this notion. At each establishment, up to 25 workers are randomly sampled and asked the following question:
"In general, how much influence do you have about the range of tasks you do in your job?" Responses are recorded on a four-point scale (1 = "none", 2 = "a little", 3 = "some", 4 = "a lot"). We code all responses of "don't know" as missing. Since our

[5] The point that the risk measures used in the previous literature can be affected by managerial behavior has been noted in Bushman et al. (1996), Lafontaine (1992), Lafontaine and Bhattacharyya (1995), and Foss and Laursen (2005).

[6] Other studies that formalize the notion of the delegation of authority in the agency framework include Aghion and Tirole (1997) and Al-Najjar (2001).

measures of incentive pay, risk, and firm characteristics are measured at the establishment level, for the authority measure we aggregate the worker authority responses to the establishment level by taking the modal worker response. The idea is that the most frequently occurring worker response to the authority questions within an establishment reflects the degree of authority experienced by the typical worker in that establishment. We use the following four-valued authority measure and the four binary indicators implied by it:[7]

Authority = 1 if establishment's modal worker response is "none"
= 2 if establishment's modal worker response is "a little"
= 3 if establishment's modal worker response is "some"
= 4 if establishment's modal worker response is "a lot"
Authority1 = 1 if establishment's modal worker response is "none"
= 0 otherwise
Authority2 = 1 if establishment's modal worker response is "a little"
= 0 otherwise
Authority3 = 1 if establishment's modal worker response is "some"
= 0 otherwise
Authority4 = 1 if establishment's modal worker response is "a lot"
= 0 otherwise

IV. EMPIRICAL ANALYSIS

The "risk" question was only asked of establishments in the trading sector, producing 1591 responses.[8] Of these, 1590 establishments responded to the questions about performance-related pay. Descriptive statistics for all variables in our analysis are displayed in Table 2 for the analysis sample of 1590 establishments. In Table 2 and in all of our analysis we use establishment weights; in most cases worker weights yield the same qualitative results. Some of the variables in our analysis contain missing values, and we estimate all of our models using listwise deletion. The main source of missing

[7] In Appendix A we consider some alternative measures of authority.
[8] The WERS defines the trading sector as the private sector, plus trading government corporations and nationalized industries.

information is the measure of worker authority, since only 1277 of the 1590 establishments reported any worker responses to the authority question.[9] Our analyses include controls for firm characteristics, and we define these in Appendix B. In the following subsections we address the four questions posed at the end of the Introduction.

A. Is there empirical support for the risk-incentives tradeoff predicted by agency theory?

To investigate whether a tradeoff between risk and incentives can be identified in the WERS data, we estimate the following probit model:

$$\text{Prob}(\textit{Performance Pay}_i = 1) = \Phi(\alpha \textit{Risk}_i + \mathbf{X}_i\boldsymbol{\beta})$$

where $\mathbf{X}_i$ is a vector of controls for firm characteristics, and i indexes establishments. Agency theory predicts $\alpha < 0$, and we find support for this prediction. As seen in Table 3, the estimated α is negative, though it is statistically significant only at the ten percent level on a one-tailed test.[10] The implied change in the predicted probability that incentive pay is offered when *Risk* increases from 0 to 1 (evaluating other covariates at their means) is -0.057. This magnitude is substantial, given that the mean of *Performance Pay* is 0.196. On average, an increase in *Risk* from 0 to 1 is associated with a decrease of 29 percent in the predicted probability that performance-related pay is used.[11]

[9] A table of means on this smaller subsample of N = 1277 matches Table 2 very closely.

[10] Since the negative relationship between risk and incentives predicted by the principal-agent model is a directional hypothesis, we use one-tailed hypothesis tests as the basis for declaring results statistically significant. We adhere to this convention throughout the paper whenever a directional hypothesis is implied by the theory.

[11] Since the binary risk measure is a subjective response, it is subject to potential classification errors, and we investigated the sensitivity of the estimated α to such errors using likelihood-based methods (Carroll, et al. 2006), finding that the parameter of interest, α, was relatively insensitive to such errors.

B. Is there empirical support for Prendergast's assumption that worker authority and incentives are positively related?

A key assumption underlying Prendergast's model is that authority and incentives are positively related.[12] This is because in risky settings the principal wants to switch from monitoring labor inputs to monitoring outputs. In such settings, the firm delegates decision-making authority to the worker but accompanies this authority with output-based pay. To test this assumption empirically, we estimate the following probit model:[13]

$$\text{Prob}(\textit{Performance Pay}_i = 1) = \Phi(\beta_2 \textit{Authority}_{2i} + \beta_3 \textit{Authority}_{3i} + \beta_4 \textit{Authority}_{4i} + \mathbf{X_i\beta}).$$

Empirical support for a positive correlation between authority and incentives would be implied by positive and statistically significant estimates of β_2, β_3, and β_4. As seen in Table 4, a positive relationship between authority and incentives is supported in the data. While the estimates of β_2 and β_3 are statistically indistinguishable from zero, the estimated β_4 is positive and significant at the five percent level on a one-tailed test.

The WERS also contains retrospective information on changes in incentive pay and authority over time. Respondent managers who were in establishments that had been in operation for at least five years at the time of the survey were presented with a list of

[12] A number of empirical studies find such a relationship. MacLeod and Parent (1999) use a cross-firm, cross-industry data set to show that jobs using high-powered incentives, namely either piece rate or commission contracts, are associated with greater worker authority than are hourly paid or salaried jobs. Nagar (2002) analyzes the retail banking industry, finding that branch managers with more authority receive more incentive based pay. Wulf (2006) looks at a panel of 250 publicly traded U.S. firms and finds that the pay of division managers with broader authority, i.e., those designated as corporate officers like president, CFO, principal accounting officer or VP, is more sensitive to firm sales growth than division managers who are not officers (though there is no difference in terms of sensitivity to division sales growth). Foss and Laursen (2005) find a positive correlation between performance pay and delegation in a cross section of 993 Danish firms surveyed in 1996.

[13] Both authority and incentives are chosen by the principal in pursuit of higher profit and are therefore endogenous. Since these variables are jointly determined, there is no reason to prefer incentives over authority as a dependent variable, and an alternative way to address Prendergast's first key assumption would be to estimate an ordered probit, with an authority measure as the dependent variable and the dummy variable for incentive pay as an independent variable. We defer a discussion of the endogeneity of authority to later in the section, where we extend our main test of Prendergast's model to treat authority as endogenous.

items, and for each item they were asked if there had been any change at the establishment within the last five years, as well as how substantial the change had been. The following two items pertain to performance-related pay and degree of worker authority: "The proportion of pay for non-managerial employees which is related to measures of performance" and "The amount of employee influence over the way they do their job."[14] Responses to both items were on a five-point scale: "gone down a lot", "gone down a little", "stayed the same", "gone up a little", "gone up a lot". Since only a small number of respondents reported that either of these items went down during the last five years, we aggregate the lowest 3 categories. That is, we create a dependent variable, $\Delta Performance\ Pay_{NM}$, capturing the "increase in incentive pay during last five years", defined as "1 = stayed the same or gone down", "2 = gone up a little", "3 = gone up a lot". For changes in authority we create three dummy variables ($\Delta Authority_1$, $\Delta Authority_2$, $\Delta Authority_3$) corresponding to the categories "stayed the same or gone down", "gone up a little", and "gone up a lot." We then estimate an ordered probit with the incentives measure as the dependent variable, including the authority dummies and the controls for firm characteristics. Results are displayed in Table 5 and strongly support a positive relationship between incentive pay and authority. Increases in the degree of worker authority during the last five years are strongly positively related to increases in the fraction of non-managerial pay that is performance-based.

[14] In fact, Prendergast's model, taken literally, implies no predictions about the proportion of the agent's pay that is performance-related. In his model the principal chooses to pay the agent either on an output-based or an input-based scheme. Nonetheless, the basic logic of Prendergast's argument should extend to the proportion of compensation that is output-based.

C. Is there empirical support for Prendergast's assumption that risk and delegation of authority are positively related?

The second key assumption underlying the Prendergast model is that delegation of authority is more likely in risky settings, so that authority and risk are positively related.[15] To test this empirically, we estimate an ordered probit model in which the four-valued dependent variable is *Authority*, and *Risk* is the key independent variable. The results, displayed in Table 6, reveal a positive coefficient on *Risk* that is statistically significant at the five percent level.[16] These results clearly support Prendergast's assumption that risk and authority are positively related.

D. Is there empirical support for the main testable implication of Prendergast's model?

Prendergast argues that if controls for worker authority are added to risk-incentives regressions, evidence favoring a negative relationship between risk and

[15] Informal observations from certain production environments suggest that authority and risk are positively related. For example, Prendergast (2002) notes that "the most likely place to observe data on the correlates of agents' responsibilities is in the franchising literature; franchisees are offered more responsibilities than the managers of company-owned stores. This theory suggests that the decision to franchise (and hence delegate responsibility to the agent) will be positively correlated with uncertainty" (p. 1098). Lafontaine (1992) finds that the decision to franchise is significantly and positively related to her measure of uncertainty, the likelihood of bankruptcy. A positive relationship between authority and risk has also been found in the disparate settings of sharecropped farms and retail banking. In a comparison of rice and tobacco farmers in Andhra Pradesh, India, Rao (1971) found that rice farms, which are characterized by significantly less uncertainty than tobacco farms in terms of crop yield volatility, are more likely to be sharecropped than leased out using fixed rental contracts. Since sharecroppers hold less decision-making power than do renters of farms, this can be interpreted as evidence of a positive relationship between risk and authority in an agency framework. Finally, using data on branch manager practices from 100 U.S. retail banks, Nagar (2002) found evidence that banks that face greater uncertainty in terms of volatility in earnings and bank growth tend to delegate more authority to branch managers. Also, Foss and Laursen (2005) find a positive relationship between risk and authority in a survey of 993 Danish firms sampled in 1996.

[16] Changes in the predicted probabilities, as the binary covariate increase from zero to one, for all four discrete outcomes for worker authority (ordered from the lowest to highest) are as follows: -0.035, -0.030, -0.059, 0.124, where the other covariates are evaluated at their means. Thus, an increase in *Risk* from 0 to 1 is associated with an increase in the predicted probability that the degree of worker authority is reported to be "a lot" and decreases in the predicted probabilities that it assumes any of the three lower values (corresponding to responses of "some, "a little" or "none").

incentives should strengthen. As a starting point we augment the model in Table 3 with controls for worker authority as follows:

$$\text{Prob}(\textit{Performance Pay}_i = 1) = \Phi(\alpha \textit{Risk}_i + \beta_2 \textit{Authority}_{2i} + \beta_3 \textit{Authority}_{3i} + \beta_4 \textit{Authority}_{4i} + \mathbf{X_i\beta})$$

Prendergast's argument suggests that α should decrease when authority controls are added to the model. Table 7 displays the results, which support this prediction. The coefficient of *Risk* decreases from -0.30 (Z = 1.48) to -0.38 (Z = 1.78) when authority controls are added to the model. The difference in *Risk* coefficients between the two models is statistically significant at the ten percent level on a one-tailed test (p-value = 0.052). Furthermore, the estimate of β_4 is positive and statistically significant, confirming the positive relationship between authority and incentive pay that we documented in Subsection B. The other two authority coefficients are also positive, though they are statistically insignificant.

The results thus far appear supportive of the main testable implication of Prendergast's model. However, to address the potential concern that authority is endogenous, we estimate a simultaneous-equations model of incentives and authority, allowing for correlation between the unobserved determinants of both variables. It is convenient to aggregate the authority measure from four categories to three by combining the two lowest responses (i.e. "none" and "a little"), as follows:

$\textit{AUTHORITY}_{\textit{RANGE}}\textit{(W)1}$ = 1 if establishment's modal worker response to the amount of worker discretion over the range of tasks done on the job is " none" or "a little" (= 0 otherwise)

$\textit{AUTHORITY}_{\textit{RANGE}}\textit{(W)2}$ = 1 if establishment's modal worker response to the amount of worker discretion over the range of tasks done on the job is"some" (= 0 otherwise)

$\textit{AUTHORITY}_{\textit{RANGE}}\textit{(W)3}$ = 1 if establishment's modal worker response to the amount of worker discretion over the range of tasks done on the job is "a lot" (= 0 otherwise)

This aggregation reduces the number of discrete states in the simultaneous equations model from eight to six. We include "(W)" in the variable name to emphasize that these measures reflect worker perceptions.

Letting Y_i^* and A_i^* denote latent indexes reflecting the propensity of establishment i to offer performance-related pay and to delegate authority, respectively, and letting Y_i, A_{1i}, A_{2i}, and A_{3i} denote the binary realizations of performance-related pay and the three levels of worker authority ("none" or "a little", "some", and "a lot"), our model is:

$$Y_i^* = \alpha Risk_i + \beta_2 A_{2i} + \beta_3 A_{3i} + \mathbf{X}_i\boldsymbol{\delta} + \varepsilon_{1i} \qquad (4.1)$$
$$A_i^* = \gamma Risk_i + \mathbf{W}_i\boldsymbol{\lambda} + \varepsilon_{2i} \qquad (4.2)$$
$Y_i = 1$ if $Y_i^* \geq 0$
$= 0$ if $Y_i^* < 0$
$A_{1i} = 1$ if $A_i^* \leq 0$
$= 0$ if $A_i^* > 0$
$A_{2i} = 1$ if $0 < A_i^* \leq c$
$= 0$ otherwise
$A_{3i} = 1$ if $A_i^* > c$
$= 0$ otherwise

where $c > 0$. We assume the joint distribution of disturbances is bivariate normal, so $(\varepsilon_{1i}, \varepsilon_{2i}) \sim BVN(0,0,1,1,\rho)$. The model implies the following six possible outcomes:

Six Possible Discrete Realizations of $(Y_i, A_{1i}, A_{2i}, A_{3i})$

Probability	Y_i =	A_{1i} =	A_{2i} =	A_{3i} =
$P_{1i}(\boldsymbol{\theta})$	1	1	0	0
$P_{2i}(\boldsymbol{\theta})$	1	0	1	0
$P_{3i}(\boldsymbol{\theta})$	1	0	0	1
$P_{4i}(\boldsymbol{\theta})$	0	1	0	0
$P_{5i}(\boldsymbol{\theta})$	0	0	1	0
$P_{6i}(\boldsymbol{\theta})$	0	0	0	1

Let $Z_{ji} = 1$ if workplace i experiences the j^{th} outcome
$= 0$ otherwise, for i = 1, 2, … , N and j = 1, 2, …, 6

Then the log-likelihood function is $L = \sum_{i=1}^{N} \sum_{j=1}^{6} \omega_i Z_{ji} \log P_{ji}$ where ω_i is the sampling weight for establishment i, and the weights are scaled to sum to N.[17]

To facilitate identification, the vector of controls $\mathbf{W}_i$ includes some additional variables not contained in $\mathbf{X}_i$. The WERS employee survey asks each of the workers (up to 25 per establishment) how long they have been employed at the establishment. Responses are recorded as a few discrete indicators for ranges of years. In each establishment we select the workers who provided the modal response to the authority question. For this subsample of workers we compute the fraction of workers with job tenures of less than one year, the fraction with tenures of at least one year but less than two years, and the fraction with tenures of at least two years but less than five years. We include these three indicator variables in $\mathbf{W}_i$, so the excluded category is the fraction with job tenures of five years or more. The rationale is that workers who have been with the establishment for only a short time are likely to be granted less authority over the range of tasks performed than workers who have been with the establishment for a long time. So the longer the average tenure for the group of workers providing the modal response to the authority question, the lower the modal authority response should be. While the

[17] Since both endogenous variables are observed only discretely, each of the 6 probabilities $P_{ji}(\boldsymbol{\theta})$ is a double integral of the bivariate normal density $f(\varepsilon_{1i}, \varepsilon_{2i})$. Suppressing all subscripts i, and letting K denote $\alpha Risk_i + \beta_2 A_{2i} + \beta_3 A_{3i} + \mathbf{X}_i\boldsymbol{\delta}$, the expression for $P_{1i}(\boldsymbol{\theta})$ is as follows:

$$P_1(\theta) = \Pr ob(Y = 1, A_1 = 1, A_2 = 0, A_3 = 0) = \Pr ob(Y^* \geq 0, A^* \leq 0) =$$

$$\int_{-\infty}^{-(\gamma Risk + W\lambda)} \int_{-K}^{\infty} f(\varepsilon_1, \varepsilon_2) d\varepsilon_1 d\varepsilon_2 = \int_{-\infty}^{-(\gamma Risk + W\lambda)} f(\varepsilon_2) \int_{-K}^{\infty} f(\varepsilon_1 | \varepsilon_2) d\varepsilon_1 d\varepsilon_2 = \int_{-\infty}^{-(\gamma Risk + W\lambda)} f(\varepsilon_2) \left(1 - \Phi\left(\frac{-K - \mu}{\sigma}\right)\right) d\varepsilon_2 =$$

$$\int_{-\infty}^{-(\gamma Risk + W\lambda)} f(\varepsilon_2) \Phi\left(\frac{K + \mu}{\sigma}\right) d\varepsilon_2$$

job tenure variables can be expected to predict the degree of authority granted to those particular workers, they should not predict whether the establishment as a whole uses performance-related pay.[18]

We estimate equations (4.1) and (4.2) jointly by maximum likelihood. Table 8 displays the estimation results for equation (4.1) under various sets of imposed constraints. In columns 1 and 2 we impose $\rho = 0$, whereas in columns 3 and 4 we treat ρ as a free parameter; thus, columns 1 and 2 treat worker authority as exogenous whereas columns 3 and 4 treat authority as endogenous. In columns 1 and 3 we impose $\beta_2 = \beta_3 = 0$ (that is, we exclude the authority variables from the right-hand side) whereas in columns 2 and 4 we include the authority variables, estimating β_2 and β_3. Thus, comparing columns 1 and 2 (3 and 4) gives the test of the main implication of Prendergast's model for the case of exogenous (endogenous) worker authority.

When authority is treated as endogenous, adding authority variables to the right-hand side of a risk-incentives probit decreases the risk coefficient from -0.30 (Z = 3.96) to -0.35 (Z = 1.633). Furthermore, when authority variables are included, they are positive and (for the dummy variable corresponding to the greatest degree of worker authority) statistically significant.[19] Qualitatively these results match those that we found when worker authority was treated as exogenous. The estimated value of ρ is 0.29,

[18] Since the model is nonlinear the exclusion restrictions can be tested. If the simultaneous-equations model is estimated with these 3 dummy variables included in the incentive pay equation as well as the authority equation, a likelihood ratio test cannot reject the null hypothesis that the 3 variables have coefficients of zero in the incentive pay equation (p-value = 0.285).

[19] We also note that the variables unique to the authority equation are related to authority in the manner we expected. The only one that is statistically significant is the fraction of workers providing the modal response to the authority question with at least one year but less than two years of job tenure. The coefficient on this variable is negative and statistically significant (Z = 1.77), indicating that increases in this fraction (relative to the fraction with five or more years of tenure with the establishment) are associated with a lower degree of worker authority. The other two tenure variables included in $\mathbf{W}_i$ are far from statistically significant.

suggesting a positive correlation between the unobserved determinants of performance pay and the degree of authority delegated to workers. However, it is far from statistically significant ($Z = 0.56$). Thus, the null hypothesis that $\rho = 0$ cannot be rejected. This means that in the empirical tests it is reasonable to use a comparison of columns 1 and 2 as the basis for evaluating the main testable prediction of Prendergast's model, even though in the theoretical model authority is endogenous. Our conclusion is that including authority variables in a risk-incentives probit strengthens the negative relationship between risk and incentives, supporting Prendergast's main testable implication.

We conclude this section with a discussion of Foss and Laursen (2005), the previous study that is closest to ours in its objectives.[20] Their study is based on 993

[20] Three other studies are also related to our analysis in that they incorporate authority into empirical models of risk and incentives. Wulf (2007) uses a panel of 250 publicly-traded U.S. firms to show that in the presence of a control for whether division managers have officer status (such as president, CFO, VP) the tradeoff between division-level risk and manager incentives is stronger than when the control is omitted. This result is consistent with the notion of authority as a mitigating factor in the risk-incentives relationship. However, one aspect of the analysis that makes it somewhat difficult to interpret this as a direct test of Prendergast's main implication is that the set of covariates in the regressions which omit authority are different from those that include authority.

Using a cross section of 100 retail banks in the U.S., Nagar (2002) finds that, holding constant the authority delegated from top bank management to branch managers (in terms of hiring, promotions, hours and investment decisions), there is a negative but statistically insignificant relationship between uncertainty (as proxied by volatility in earnings and bank growth) and incentive pay (as reflected by the proportion of bank managers' pay comprised of bonuses). Since that study does not estimate models that omit authority, we are unable to make a comparison of the relation between risk and uncertainty when authority is controlled as opposed to when it is not, so the study does not provide a test of Prendergast's main implication.

Finally, Adams (2005) analyzes the manufacturing establishments from the 1998 WERS (a subsample of 166 establishments of the 1590 we consider). Adams treats the unit of observation as the worker rather than the establishment, but incentive pay is not observed in the 1998 WERS at the level of individual workers, so he attempts to infer the measure using establishment-level questions about what fraction of the workers in the given worker's occupation receives either profit-related pay or ESOPs (if more than 80% of the workers receive such payments, the given worker is assumed to receive it, if less than 20% of the workers receive such payments, the given worker is assumed not to receive it, and if between 20% and 80% of the workers receive such payments, the given worker is dropped from the sample). In principle, this approach could misclassify 100 percent of the cases. Furthermore, the central question of interest concerns the relationship between risk and incentives, and the risk measure available in the WERS only varies across establishments and not across workers within an establishment. So for the purpose of measuring the risk-incentives tradeoff, no additional information comes from disaggregating to the worker level, since this parameter is identified only by variation across establishments. Finally, Adams' measure of performance pay (a hybrid of profit-sharing and ESOP) is a group scheme, whereas our measure of individual-based performance pay more closely matches the theory. We also note that Adams's main

Danish firms sampled in 1996. Their performance-pay measure is given by the question "How large a share of the firm's workforce is involved in performance pay?" Their authority measure is given by the question "How large a share of the firm's workforce is involved in delegation of responsibility?" Responses to both questions are (none, < 25 percent, 25 – 50 percent, or > 50 percent). They refer to their risk measure as "within-industry variance in profitability". To construct this variable, the authors assign each firm in their sample to one of 70 industry categories. Within each of these 70 groups, the authors compute the variance of firm profits, calculated using only those firms with non-missing profit data in each of the years 1992, 1993, and 1994. Each firm's value for the risk measure is the variance that was computed for all firms belonging to the same industry category, so that the risk variable in their analysis assumes only 70 possible values. They then estimate an ordered probit model using incentive pay as the dependent variable and the 70-valued risk measure as an independent variable, along with a set of controls.[21]

To understand the correct interpretation of the risk-incentives relationship estimated in this empirical model, it is useful to consider first a more general empirical specification that nests the Foss and Laursen model. The general model includes on the right-hand side 70 industry dummies and the set of control variables used by Foss and

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measure of risk (a dummy equaling 1 if the current state of the market is increasing or decreasing as well as turbulent) seems to us less natural than the one we use.

[21] The controls include firm size, 3 sector dummies, a dummy for whether the firm is a subsidiary, the extent to which the firm is innovative, and the perceived change in the level of competition. The authors interpret the last 2 variables in this list as alternative measures of risk rather than as controls. However, we prefer to focus on their measure based on the variance of profitability when interpreting their results, since we see this concept as more direct and closely tied to risk than either of the alternative measures, despite the concern that it is subject to employer influence (and therefore endogenous), unlike our measure. The authors also acknowledge that this measure "is the more conventional measure of uncertainty used in the existing literature." (p. 253)

Laursen, but it excludes their risk measure. For the purpose of explaining variation in the use of incentive pay across firms in a cross section, including a full set of industry dummies would be quite a natural approach to take given that we expect the incidence of incentive pay to vary across industries for many reasons, so the general model would be a useful starting point for analyzing the data. The coefficients on the industry dummies in this general model would capture the effects of a wide array of factors (including, but not limited to, risk in the production environment) specific to each of the 70 industries. Next, suppose that 70 parametric restrictions are imposed on this general model, so that the ratio of every pair of coefficients on the industry dummies is constrained to equal a constant that the researcher specifies (in particular, this constant is the ratio of the within-industry variances in profit for the particular pair of industries). Implicit in these 70 restrictions is the strong assumption that the coefficients of each industry dummy reflect the effect of risk and nothing else. Imposing the entire set of restrictions reduces the 70 industry dummies to a single linear combination of these dummies, namely the risk variable used by Foss and Laursen, so that only one parameter (apart from those associated with the controls) is estimated rather than 70. Since their model is a highly restricted version of the general model, one could test their restrictions simply by estimating the general model and comparing the ratios of each pair of estimated coefficients of the industry dummies to the particular values imposed on these parameters by Foss and Laursen. We expect that the restrictions would be rejected, and we think that the variable that the authors interpret as a measure of risk in the production environment is better thought of as simply an arbitrary linear combination of industry dummies. In

short, we think it is better to estimate the coefficients of industry dummies than to impose them *a priori*.

Turning to their results, Foss and Laursen find positive and statistically significant relationships between risk and incentives, between risk and authority, and between authority and incentives. Finally, if authority is added as a control to the risk-incentives (ordered probit) model, the estimated coefficient on risk remains positive and statistically significant but slightly diminishes in magnitude from 3.049 to 2.841. The authors also aggregate the authority and incentives responses from 4 categories to 2 for the purpose of estimating a bivariate probit model that allows for correlation between the unobserved determinants of both outcomes. Their results from the bivariate probit analysis are qualitatively the same as those just stated, with one exception. Now, when authority is added as a control in the incentives equation, the risk coefficient drops considerably in magnitude (from 4.931 to 1.689) and loses statistical significance at conventional levels. The authors note, however, that this same qualitative result emerges if the two equations in the bivariate probit model are estimated separately, suggesting that the result is at least partially due to aggregating the authority and incentives measures from 4 categories to 2.

These results support the following 3 hypotheses put forth by Foss and Laursen:

H1: "There is an overall positive and significant relation between environmental uncertainty and the use of performance pay."

H2a: "Delegation and environmental uncertainty are positively correlated."

H2b: "After controlling for delegation, there will be no relationship between uncertainty and performance pay."

Regarding H1, it is worth noting that while Prendergast's model predicts a positive relationship between risk and incentives, this is only because his model assumes risk-neutral agents, and he is careful to state that in the real world the standard theoretical channel of influence suggesting a negative relationship should also be present, as suggested by the mixed empirical evidence in Table 1. Similarly, H2b is implied by Prendergast's model only because of the assumption of risk-neutral agents. If agents are risk-averse so that the risk-incentives tradeoff predicted by traditional agency theory is present, then after controlling for delegation there will be a *negative* relationship between uncertainty and performance pay.

Given the strong maintained assumption of risk-neutral agents that underlies H1 and H2b, the Foss and Laursen results might be interpreted as supportive of Prendergast's model. However, in the absence of this maintained assumption their results leave open the question of why the risk-incentives relationship in their models remains positive (though not statistically significant in the models that aggregate incentives and authority from 4 categories to 2) even after controlling for delegation. One interpretation is that alternative theories to Prendergast's (that have nothing to do with delegation of authority) play an important role in explaining the mixed nature of the empirical results in Table 1, so that even after controlling for delegation a negative risk-incentives relationship fails to emerge. Another possible interpretation is that the nature of the authority measure does not allow a precise test of the implication of Predergast's model. The notion of the fraction of workers at the firm "involved in the delegation of responsibility" is rather vague and open to a variety of interpretations, and it is unclear to what extent it captures

the *degree of authority over the range of tasks performed* which is the central idea in Prendergast's theory.

V. SUMMARY AND CONCLUSION

In this study we use a large, nationally representative cross section of British establishments, containing responses both from employers and from multiple workers in each establishment, to shed light on the four empirical questions posed in the Introduction. In answer to the first question, we find a negative relationship between risk and incentives as predicted by the standard principal-agent model. On average, greater turbulence in the market for the establishment's main product or service is associated with a lower probability of performance-related pay for the establishment as a whole. In answer to the second and third questions, we find evidence supporting a positive relationship between performance-related pay and the degree of worker authority over the range of tasks performed, and evidence supporting a positive relationship between risk and the degree of worker authority. Both are key assumptions of Prendergast's (2002) theory.

In answer to the fourth question, our results suggest that when measures of worker authority are included in a risk-incentives model, the evidence favoring a negative relationship between risk and incentives strengthens. Since both key assumptions of Prendergast's theory are supported in the data as well as its main testable implication, we interpret the overall evidence in this empirical test of his theory as supportive. The evidence suggests that Prendergast's theory is at least part of the reason why a vast empirical literature has failed to uncover the negative relationship between risk and

incentives that has been central to agency theory for nearly three decades. We conclude with four comments.

First, while our results on the risk-incentives tradeoff represent only one study in a vast empirical literature that has found mixed evidence, we believe the breadth of our sample (which is nationally representative of all British establishments) makes our results particularly interesting. As seen in Table 1, while many analyses of the risk-incentives tradeoff have been conducted, the heavy focus has been on a relatively small set of worker groups, in particular groups that, it is fair to say, are atypical. For example, while the number of jobs held by either CEOs or sharecroppers is negligible, over half of the studies in Table 1 focus on these two groups. The general point is that it is difficult to know what relative weights to assign to the rows of Table 1 in forming an overall evaluation. We think the present study, based on a broad and nationally representative sample of establishments, contributes to forming such an overall evaluation.

Second, an appealing feature of the analysis is that our risk measure is less subject to influence by agent behavior (and therefore endogenous) than the objective risk measures that are frequently used in this literature. Endogeneity of empirical measures of risk presents another obstacle, in addition to the one cited in the previous paragraph, that hinders the extent to which the studies in Table 1 can be used as the basis for forming an overall evaluation of the empirical importance of the risk-incentives tradeoff.

Third, we hope that our results will stimulate further research in this area using other data sets. Since we have focused only on Britain, due to the strengths of the WERS data for testing Prendergast's theory, it would be useful for future tests to use data from the United States and other countries. While we cannot rule out the possibility that the

empirical support of Prendergast's model is specific to Britain, we will be rather surprised if this is confirmed in future work. We see nothing peculiar to Britain in the fundamental workplace issues Prendergast's model addresses, and we therefore expect the empirical support for his model in Britain to generalize to data sets from other countries. Furthermore, though our binary measure of incentive pay proved to be quite informative, more detailed information concerning how the intensity of incentive pay varies across organizations would also be interesting.

Finally, while we believe our results suggest that Prendergast's theory at least partially explains why the empirical literature has failed to uncover a risk-incentives tradeoff, this does not rule out that alternative theories may also play a role. Our focus on Prendergast's theory in this analysis is driven largely by the availability of an authority measure that corresponds exactly to the notion discussed by Prendergast. Though we believe our evidence is supportive of Prendergast's theory, we do not see it as casting doubt on the alternative models, and we see investigation of these alternatives as a promising direction for future work with other data sets.

APPENDIX A

ALTERNATIVE MEASURES OF INCENTIVE PAY AND AUTHORITY

A potential drawback of our measure of incentive pay is that it refers to group performance-related schemes as well as individual performance-related schemes, whereas the theory we address in this paper pertains to individual performance-related schemes. To explore this issue, we use some further information in the WERS employer survey. If the respondent reports that performance-related pay is used at the establishment and that "any non-managerial occupations [are] eligible", the respondent is then asked what measures of performance are used to determine the amount of performance-related pay. Respondents can list as many of the following responses as they wish, in addition to providing their own responses not on the list: "1 = Individual performance / output", "2 = Group or team performance / output", "3 = Workplace-based measures", "4 = Organisation-based measures". The most common response is "1", either alone or in combination with other choices. Using this information we modify the binary performance measure we have used throughout the analysis. If an establishment reports the use of performance-related pay but does not include "1 = Individual performance / output" in its list of responses to the above question, we reclassify the binary performance pay measure for this observation from 1 to 0. The idea behind this reclassification is to create a binary incentive pay measure that equals one only if it can be determined with certainty (abstracting from reporting and coding errors) that performance-related pay is used *and* at least some of it is based on individual performance or output.

Two points are worth noting about this modified measure. First, when the respondent lists more than one answer to the question of what type of performance-related scheme is used at the establishment, there is no way to discern the relative importance of the responses listed. Second, because the question is only asked if performance-pay is used and "any non-managerial occupations [are] eligible", if performance pay is used at the establishment but no non-managerial occupations are eligible for it we have no information on what type of performance pay is used. Thus, we only have information on the type of performance-related pay used for 357 of the 418 establishments that report the use of performance-related pay. For the remaining 61 establishments we define the binary incentive measure as "1" even though in some of these cases the performance-pay might not be based on individual performance / output.

The mean of the modified incentive pay measure is 0.151, as opposed to 0.196 for the unmodified measure we use throughout the paper. Replicating all of our analysis in the paper using the modified measure, we obtain very similar results to those we report here, and none of our conclusions change qualitatively. All of these results are available upon request.

Although the measure of worker authority we use throughout the analysis exactly matches the notion described in Prendergast (2002), we also consider some alternative authority measures. These are measures of worker discretion over how tasks are executed (as opposed to the range of tasks performed). The questions are asked both of the employer and of the workers, allowing us to construct the following employer-perceived and worker-perceived measures of authority over how tasks are executed:

Worker-Perceived Worker Authority Measures

$AUTHORITY_{HOW}(W)1$ = 1 if the establishment's modal worker response to the amount of worker discretion over how tasks are executed is "none" or "a little"
= 0 otherwise

$AUTHORITY_{HOW}(W)2$ = 1 if the establishment's modal worker response to the amount of worker discretion over how tasks are executed is "some"
= 0 otherwise

$AUTHORITY_{HOW}(W)3$ = 1 if the establishment's modal worker response to the amount of worker discretion over how tasks are executed is "a lot"
= 0 otherwise

Firm-Perceived Worker Authority Measures

$AUTHORITY_{HOW}(F)1$ = 1 if firm-perceived worker discretion over how tasks are executed is none" or "a little"
= 0 otherwise

$AUTHORITY_{HOW}(F)2$ = 1 if firm-perceived worker discretion over how tasks are executed is "some"
= 0 otherwise

$AUTHORITY_{HOW}(F)3$ = 1 if firm-perceived worker discretion over how tasks are executed is "a lot"
= 0 otherwise

The variable names include "(W)" or "(F)" to indicate which worker authority measures reflect worker perceptions and which reflect firm perceptions. One difference between the worker-perceived measures and the firm-perceived measures is that the question in the employer survey pertains to the discretion of workers in the establishment's largest occupational group, whereas the question from the worker survey is based on a random sample of workers in the establishment. That is, in the employer survey the respondent employer is asked to rate the level of worker authority in the establishment's "largest occupational group" rather than in the establishment as a whole.

We experiment with different combinations of authority controls (authority over range of tasks performed, worker-perceived authority over how tasks are executed, employer-perceived authority over how tasks are executed). Results are displayed in Table A1 and reveal that the authority measure that suggests the strongest empirical support for Prendergast's theory is also the measure that best matches the notion of authority discussed in his paper (namely authority over the range of tasks performed). That is, the risk coefficient decreases by the most when these particular authority measures are included as controls.

The coefficients on the firm-perceived authority measures often have the wrong sign (negative) in Table A1, and a possible reason for this is that these variables measure the degree of authority in the establishment's largest occupational group rather than the establishment as a whole. We might expect that if the dependent variable measured incentive pay in the largest occupational group rather than in the establishment as a whole, the firm-perceived worker authority measures might have positive effects. To test this hypothesis, we first construct a dummy variable equaling one if performance-related pay is used in the establishment's largest occupational group and zero otherwise. We

then modify this binary incentives measure in the manner described at the start of this section (that is, we reclassify from "1" to "0" the observations for which individual performance/output is *not* used in awarding performance-related pay to workers in the largest occupational group).[22] We make this modification because in this case it actually matters, in the sense that support for Prendergast's model is only found if the modification is made. That is, without the modification the risk coefficient decreases only trivially when authority controls are included in the model. In contrast, as mentioned earlier in the section, when the dependent variable is performance-related pay in the establishment as a whole rather than in the largest occupational group, the test of Prendergast's prediction yields very similar results whether or not the modification is made.[23]

Results using performance-related pay (based on individual performance/output) in the establishment's largest occupational group are displayed in Table A2, with various combinations of authority controls included. Several points are worth noting. First, our hypothesis that the firm-perceived measures of worker authority would be positively related to incentives if the incentive measure (like the authority measure) is restricted to the establishment's largest occupational group is correct. The firm-perceived worker authority measures are now always positive and statistically significant. Second, all of the other authority measures are positive in all specifications and frequently achieve statistical significance. Third, as was the case in Table A1 using incentive pay in the establishment as a whole as the dependent variable, the authority measure that suggests the strongest empirical support for Prendergast's theory is also the measure that best matches the notion of authority (namely authority over the range of tasks performed) discussed in his paper. Fourth, the risk coefficient is negative and statistically significant in all specifications, even in the absence of authority controls. The first column of the table further strengthens support for the risk-incentives tradeoff implied by the standard agency model (our first empirical question).

[22] We are able to make this reclassification unambiguously for all 252 establishments that report the use of performance-related pay in the establishment's largest occupational group. The reason is that even though the follow-up question (asking what output measure is used for awarding performance-related pay) is asked only of establishments where some non-managerial workers are eligible, it turns out that this criterion is met for all 252 establishments.

[23] As seen in Table A1, for which the dependent variable is performance-related pay in the establishment as a whole, the risk coefficient decreases from -0.30 in the first column to -0.37 in the last column. If instead we modify the dependent variable as described at the start of this section, the risk coefficient decreases from -0.27 in the first column to -0.35 in the last column.

APPENDIX B

FIRM CHARACTERISTICS USED AS CONTROL VARIABLES:

Single-Establishment Firm: dummy variable that equals 1 if the establishment is either a single independent establishment not belonging to another body, or the sole UK establishment of a foreign organization and equals 0 if the establishment is one of a number of different establishments within a larger organization

Establishment Size: total number of full time, part time, and temporary workers at the establishment

Fraction of Part Time Workers: number of part time workers at the establishment as a fraction of establishment size

Temporary Workers: dummy variable that equals 1 if there are temporary agency employees working at the establishment at the time of the survey and equals 0 otherwise

Fixed Term Workers Under One Year: dummy variable that equals 1 if there are employees who are working on a temporary basis or have fixed-term contracts for less than one year and equals 0 otherwise

Fixed Term Workers Over One Year: dummy variable that equals 1 if there are employees who have fixed term contracts for one year or more and equals 0 otherwise

Number of Recognized Unions: Total number of recognized unions at the workplace

100% Workers Unionized: dummy variable that equals 1 if 100% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level and equals 0 otherwise (employee-perceived measure)

80-99% Workers Unionized: dummy variable that equals 1 if 80-99% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level and equals 0 otherwise (employee-perceived measure)

60-79% Workers Unionized: dummy variable that equals 1 if 60-79% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level and equals 0 otherwise (employee-perceived measure)

40-59% Workers Unionized: dummy variable that equals 1 if 40-59% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level and equals 0 otherwise (employee-perceived measure)

20-39% Workers Unionized: dummy variable that equals 1 if 20-39% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level and equals 0 otherwise (employee-perceived measure)

1-19% Workers Unionized: dummy variable that equals 1 if 1-19% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level and equals 0 otherwise (employee-perceived measure)

0% Workers Unionized: dummy variable that equals 1 if 0% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level and equals 0 otherwise (employee-perceived measure)

Main Activity of Establishment: 1. We produce goods or services for consumers; 2. We are a supplier of goods or services to other companies; 3. We are a supplier of goods or services to other parts of the organization to which we belong; 4. We do not produce goods or provide services for sale in the open market; 5. This is an administrative office only.

Single Product: dummy variable that equals 1 if the establishment is concentrated on one product or service and 0 if it is concentrated on several different products or services

Private Sector Franchise: dummy variable that equals 1 if the establishment is a private sector company and a franchise and equals 0 otherwise

Private Sector Non-franchise: dummy variable that equals 1 if the establishment is a private sector company but not a franchise and equals 0 otherwise

Private Sector Publicly-Traded Franchise: dummy variable that equals 1 if the establishment is a publicly-traded private sector unit and a franchise and equals 0 otherwise

Private Sector Publicly-Traded Non-franchise: dummy variable that equals 1 if the establishment is a publicly-traded private sector unit but not a franchise and equals 0 otherwise

Operation Over Five Years: dummy variable that equals one if the workplace has been operating at its present address for 5 years or more, and zero otherwise

Industry Controls: (Manufacturing; Electricity, Gas, and Water; Construction; Wholesale and Retail; Hotels and Restaurants; Transport and Communication; Financial Services; Other Business Services; Public Administration; Education; Health; Other Community Services)

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Table 1: Empirical Studies Testing the Relationship between Risk and Incentives

Study	Measure of Incentive Pay	Measure of Risk	Worker or Firm Type	Data	Econometric Methodology	Risk vs. Incentives Result
CEOs:						
Lambert & Larcker (1987)	Equity and security market returns as a proportion of CEO cash compensation	Variance of equity and security market returns	CEOs	Cross-section of 370 U.S. firms	Latent variable structural equation model	(-)
Yermack (1995)	Stock option awards to CEO	Variance of returns to firm equity	CEOs	Panel of nearly 6,000 CEO-year observations from 792 public U.S. corporations	Tobit	(0)
Bushman, Indjejikian & Smith (1996)	Use of individual performance evaluation in CEO's annual incentive bonus payment	Variance of stock returns; Correlation between accounting and stock returns	CEOs	Panel of 1476 firm-year observations from 396 public U.S. companies	OLS	(0)
Ittner, Larcker & Rajan (1997)	Relative weight placed on financial versus non-financial performance measures in CEO's annual bonus contract	Time-series variability in median industry accounting returns; Correlation between firm accounting returns and stock market returns	CEOs	Cross-section of 317 U.S. firms	Cross-sectional latent variable regression	(0)
Garen (1998)	Fraction of present value of corporate income owned by CEO	Covariation of firm returns with the market	CEOs	Cross-section of 415 U.S. corporations	OLS	(0)
Aggarwal & Samwick (1999)	Pay-performance sensitivity of top executives	Dollar stock return variance	The five highest paid executives	Panel of 1,500 largest publicly traded companies in the U.S.	Median regression; OLS with fixed effects for each executive	(-)
Core & Guay (1999)	Total dollar value of equity compensation to CEO	Idiosyncratic risk, that is, variance of stock returns from which market risk has been filtered out	CEOs	Panel of 6,214 CEO-year observations from non-financial U.S. firms	OLS on the pooled sample	(+)
Conyon & Murphy (2000)	Pay-performance sensitivity of CEO	Variance of shareholder returns	CEOs	Cross-section of U.S. and U.K. firms	OLS; Median regression	(+)
Core & Guay (2002)	Pay-performance sensitivity of top executives; Change in the value of stock and option holdings	Percent stock return variance	CEOs	Panel of 1,500 largest publicly traded companies in the U.S. (same as Aggarwal & Samwick, 1999)	OLS	(+)
Aggarwal & Samwick (2002)	Pay-performance sensitivity of top executives	Dollar stock return variance	CEOs	Panel of 1,500 largest publicly traded companies in the U.S. (same as Aggarwal & Samwick, 1999)	Median regression; Fixed effects	(-)
Mengistae & Xu (2004)	CEO pay sensitivity (annual salary + bonus)	Variance of CEO performance as captured by the ratio of operating profits to total sales	CEOs	10-year panel of 400 Chinese state-owned enterprises	OLS; Fixed effects	(-)
Shi (2005)	Pay-performance	Variance of industry	CEOs	Panel of over	OLS; Median	(+)

	sensitivity of CEO	stock returns; Variance of percent change in industry sales		2500 publicly traded U.S. firms	regression	
SHARECROPPING:						
Rao (1971)	Frequency of renting as opposed to sharecropping of farms in India	Variance of farm profits	Rice and tobacco farmers in India	Three-year panel of 104 farms from 7 rice-producing villages and three tobacco-producing villages	Correlations; OLS	(+)
Allen & Lueck (1992)	Frequency of Midwest farms rented on a cropshare basis as opposed to a cash-rent basis	Variation of crop yield per acre	Farmers in Midwestern United States	Cross-section of farms in Nebraska and South Dakota	Multinomial Logit	(+)
Ackerberg & Botticini (2002)	Whether farm is rented on a fixed-rent contract or a share contract	Type of crop	Farmers in Renaissance Tuscany	Historical data on agricultural contracts between landlords and tenants in early Rennaisance Tuscany	IV	(+)
FRANCHISES:						
Norton (1988)	Percentage of establishments that are franchise holders in the state	Demand variability in the state	Establishments in the state	Cross-section of U.S. establishments in the restaurants, refreshment places and motels industries that have both franchise and non-franchise operations	OLS; 2SLS	(+)
Lafontaine (1992)	Franchise royalty rate; Franchise fee; Proportion of branches franchised	Average proportion of discontinued outlets in the sector	Businesses across sectors	Cross-section of 548 U.S. franchisors across sectors	Tobit	(+)
Martin (1998)	Fraction of company outlets in the industry that are company-owned	Sales risk	Company outlets	Panel of companies from 18 franchising industries	Weighted least squares	(+)
OTHER WORKER GROUPS:						
Anderson & Schmittlein (1984)	Use of a direct sales force as opposed to sales representatives	Expected deviation between forecast and actual sales; Noise in measuring the results of salespersons equitably	Firms in the electronic components industry	Cross-section of 16 recognized electronic component manufacturers in the U.S.	Logit	(0)
Kawasaki & McMillan (1987)	Proportion of the firm's profit the subcontractor receives from the firm	Variance in the subcontractor's production costs	Japanese subcontractors	Aggregated industry cross-section of Japanese subcontractos	IV	(-)
John & Weitz (1989)	Fixed salary as a percentage of the sales worker's total compensation	Noise in assessing the worker's performance; Uncertainty faced by salespeople	Firms in the manufacturing sector	Cross-section of 161 U.S. manufacturing firms whose sales exceed $50 million	OLS	(0)
Leffler & Rucker	Payment per tree as opposed to lump-sum	Variance of the value of the lumber tract	Timber loggers	Private timber sales contracts	Logit	(+)

(1991)	payment by the logger to the timber tract owner			in North Carolina		
Coughlan & Narasimahan (1992)	Ratio of salary to total pay of the sales worker	Variance of the number of calls it takes to close a sale	Sales workers	Cross-section of 286 U.S. firms with sales workers	Double-limit Tobit	(0)
Oyer & Schaefer (2004)	Option plans offered to employee's other than top executives	Firm stock volatility; Industry stock volatility	Employees not in the top 10% of the firm's management ranks	Cross-section of 1,000 publicly traded U.S. firms	Logit	(+)
Nagar (2002)	Proportion of pay comprised of bonuses	Volatility in earnings; Bank growth	Branch managers	Cross-section of 100 retail U.S. banks	2SLS	(0)
Adams (2005)	Whether establishment offers profit-related pay or employee share ownership	Whether establishment produces multiple products; Whether establishment has achieved a quality standard; Whether the current state of the market is growing, declining, or turbulent	Manufacturing workers	Cross-section of 166 British manufacturing establishments	Probit	(-)
Foss & Laursen (2005)	Percentage of workers at firm who receive pay-for-performance	Level of novelty of innovations at firm; Firm's perceived change in level of competition; Variance of profitability within industry	Manufacturing and non-manufacturing workers	Cross section of 993 Danish firms surveyed in 1996	Ordered Probit; Bivariate Probit	(+)
Gibbs, Merchant, Van der Stede & Vargus (2006)	Bonuses	Extent to which performance measure reflects factors beyond manager's control; Extent to which performance measure reflects manager's overall performance	Auto dealership managers	Survey of 326 auto dealerships	Tobit	(-)
Wulf (2006)	Pay-performance sensitivity of division managers	Firm risk defined as standard deviation of firm sales growth; Division risk defined as standard deviation of division sales growth	Division managers	1986-1999 panel of over 250 publicly traded U.S. firms	Fixed Effects	(-)

TABLE 2: Descriptive Statistics

	Mean	***Standard Error***
Basic Firm Characteristics:		
Risk	0.218	0.020
Single-Establishment Firm	0.350	0.024
Fixed Term Workers Over One Year	0.140	0.016
Fixed Term Workers Under One Year	0.233	0.018
Operation Over Five Years	0.899	0.014
Main Activity of Establishment	0.686	0.022
Temporary Workers	0.193	0.017
Establishment Size	0.062	0.003
Fraction of Part Time Workers	309.931	15.364
Number of Recognized Unions	0.637	0.046
100% Workers Unionized	0.236	0.020
80-99% Workers Unionized	0.045	0.007
60-79% Workers Unionized	0.035	0.008
40-59% Workers Unionized	0.018	0.007
20-39% Workers Unionized	0.007	0.004
1-19% Workers Unionized	0.016	0.005
0% Workers Unionized	0.644	0.022
Firm Ownership:		
Private Sector Publicly-Traded Non-franchise	0.016	0.005
Private Sector Publicly-Traded Franchise	0.329	0.022
Private Sector Non-franchise	0.027	0.009
Private Sector Franchise	0.469	0.024
Industry:		
Manufacturing	0.166	0.019
Electricity, Gas, and Water	0.002	0.001
Construction	0.041	0.009
Wholesale and Retail	0.235	0.022
Hotels and Restaurants	0.088	0.013
Transport and Communication	0.048	0.010
Financial Services	0.039	0.008
Other Business Services	0.115	0.015
Public Administration	0.020	0.006
Education	0.098	0.014
Health	0.110	0.015
Other Community Services	0.038	0.008
Largest Occupational Group at Workplace:		
Managers and Administrators	0.006	0.003
Professional Occupations	0.099	0.013
Associate Professional and Technical Operations	0.056	0.010
Clerical and Secretarial Occupations	0.145	0.017
Craft and Skilled Service Occupations	0.132	0.017
Personal and Protective Service Occupations	0.170	0.018
Sales Occupations	0.162	0.019
Plant and Machine Operatives	0.138	0.017
Other Occupations	0.092	0.013
Incentive Pay:		
Performance Pay	0.196	0.019
Worker Authority:		
Authority1	0.078	0.016
Authority2	0.078	0.015

Authority3	0.526	0.027
Authority4	0.317	0.025
$AUTHORITY_{RANGE}(W)1$	0.157	0.020
$AUTHORITY_{RANGE}(W)2$	0.526	0.027
$AUTHORITY_{RANGE}(W)3$	0.317	0.025
$AUTHORITY_{HOW}(W)1$	0.032	0.011
$AUTHORITY_{HOW}(W)2$	0.307	0.025
$AUTHORITY_{HOW}(W)3$	0.660	0.025
$AUTHORITY_{HOW}(F)1$	0.281	0.020
$AUTHORITY_{HOW}(F)2$	0.441	0.024
$AUTHORITY_{HOW}(F)3$	0.278	0.023
Sample Size = 1590		

Note: Tabulations are for the 1590 establishments in the trading sector for which data on both risk and incentives are non-missing and excluding those establishments in public administration. Some of the above statistics are based on a smaller sample, however, due to missing values.

TABLE 3: Evidence of a Tradeoff Between Risk and Incentives

	Dependent Variable:
Independent Variables:	Performance Pay
Risk	-0.264*
	(0.180)
Single-Establishment Firm	0.013
	(0.167)
Fixed Term Workers Over One Year	-0.057
	(0.246)
Fixed Term Workers Under One Year	0.211
	(0.153)
Private Sector Publicly-Traded Non-franchise	0.258
	(0.479)
Private Sector Publicly-Traded Franchise	-0.091
	(0.370)
Private Sector Non-franchise	0.374
	(0.612)
Private Sector Franchise	-0.492
	(0.391)
Operation Over Five Years	0.233
	(0.210)
Main Activity of Establishment	0.429**
	(0.174)
Temporary Workers	0.090
	(0.150)
Establishment Size	0.183
	(0.120)
Fraction of Part Time Workers	-0.001**
	(0.000)
Number of Recognized Unions	0.089
	(0.072)
100% Workers Unionized	-0.358
	(0.241)
80-99% Workers Unionized	-0.232
	(0.209)
60-79% Workers Unionized	-0.027
	(0.229)
40-59% Workers Unionized	-0.547
	(0.354)
20-39% Workers Unionized	0.180
	(0.531)
1-19% Workers Unionized	-0.872
	(0.539)
Constant	-0.307
	(0.480)
Industry Controls	YES
Sample Size	1546

Note: Results are estimated coefficients from a probit, with standard errors in parentheses. *, **, and *** Denote statistical significance at the 10%, 5%, and 1% levels, respectively, using a one-tailed test for Risk and two-tailed tests for all other covariates.

Table 4: Relationship Between Incentive Pay and Worker Authority

	Dependent Variable:
Independent Variables:	Performance Pay
Authority2	-0.138 (0.388)
Authority3	0.003 (0.293)
Authority4	0.556** (0.309)
Single-Establishment Firm	0.035 (0.185)
Fixed Term Workers Over One Year	-0.022 (0.253)
Fixed Term Workers Under One Year	0.072 (0.168)
Private Sector Publicly-Traded Non-Franchise	0.302 (0.576)
Private Sector Publicly-Traded Franchise	-0.188 (0.436)
Private Sector Non-franchise	0.245 (0.681)
Private Sector Franchise	-0.645 (0.445)
Operation Over Five Years	0.372* (0.209)
Main Activity of Establishment	0.337* (0.191)
Temporary Workers	0.160 (0.157)
Establishment Size	0.287 (0.183)
Fraction of Part Time Workers	-0.001 (0.000)
Number of Recognized Workers	0.059 (0.072)
100% Workers Unionized	-0.313 (0.258)
80-99% Workers Unionized	-0.138 (0.224)
60-79% Workers Unionized	0.016 (0.289)
40-59% Workers Unionized	-0.400 (0.348)
20-39% Workers Unionized	-0.118 (0.573)
1-19% Workers Unionized	-0.933 (0.651)
Industry Controls	YES
Constant	-0.544 (0.611)
Sample Size	1245

Note: Results are estimated coefficients from a probit, with standard errors in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, based on a one-tailed test for *Authority2, Authority3 and Authority4*, and two-tailed tests for all other covariates.

Table 5: Relationship Between Changes in Incentive Pay and Worker Authority

	Dependent Variable:
Independent Variables:	ΔPerformance Pay_{NM}
$\Delta Authority_2$	0.290**
	(0.130)
$\Delta Authority_3$	0.757***
	(0.189)
Single-Establishment Firm	-0.286*
	(0.164)
Fixed Term Workers Over One Year	-0.007
	(0.193)
Fixed Term Workers Under One Year	0.010
	(0.147)
Private Sector Publicly-Traded Non-Franchise	0.487
	(0.394)
Private Sector Publicly-Traded Franchise	0.428
	(0.347)
Private Sector Non-franchise	-0.040
	(0.500)
Private Sector Franchise	0.229
	(0.356)
Main Activity of Establishment	0.042
	(0.166)
Temporary Workers	0.063
	(0.118)
Establishment Size	0.085
	(0.080)
Fraction of Part Time Workers	-0.000
	(0.000)
Number of Recognized Workers	-0.069
	(0.072)
100% Workers Unionized	-0.145
	(0.187)
80-99% Workers Unionized	-0.333
	(0.260)
60-79% Workers Unionized	0.089
	(0.236)
40-59% Workers Unionized	-0.419
	(0.383)
20-39% Workers Unionized	0.122
	(0.400)
1-19% Workers Unionized	0.491
	(0.369)
Industry Controls	YES
Cutoff 1	0.198
	(0.393)
Cutoff 2	1.111
	(0.410)
Sample Size	1378

Note: Results are estimated coefficients from a probit, with standard errors in parentheses.
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 6: Relationship Between Worker Authority and Risk

	Dependent Variable:
Independent Variables:	Authority
Risk	0.341**
	(0.153)
Single-Establishment Firm	0.042
	(0.179)
Fixed Term Workers Over One Year	0.033
	(0.163)
Fixed Term Workers Under One Year	0.098
	(0.123)
Private Sector Publicly-Traded Non-Franchise	0.596*
	(0.362)
Private Sector Publicly-Traded Franchise	1.035***
	(0.257)
Private Sector Non-franchise	1.319***
	(0.450)
Private Sector Franchise	0.913***
	(0.284)
Operation Over Five Years	0.163
	(0.189)
Main Activity of Establishment	-0.043
	(0.179)
Temporary Workers	-0.133
	(0.146)
Establishment Size	-0.051
	(0.081)
Fraction of Part Time Workers	-0.001
	(0.000)
Number of Recognized Workers	0.001
	(0.052)
100% Workers Unionized	0.411***
	(0.147)
80-99% Workers Unionized	-0.020
	(0.222)
60-79% Workers Unionized	0.295
	(0.332)
40-59% Workers Unionized	0.019
	(0.340)
20-39% Workers Unionized	2.080
	(0.593)
1-19% Workers Unionized	0.136***
	(0.332)
Industry Controls	YES
Cutoff 1	-0.367
	(0.432)
Cutoff 2	0.076
	(0.421)
Cutoff3	1.706
	(0.414)
Sample Size	1245

Note: Results are estimated coefficients from an ordered probit, with standard errors in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on a one-tailed test for Risk, but two-tailed tests for all other covariates.

TABLE 7: Testing the Main Prediction of Prendergast (2002)

	Dependent Variable:	
Independent Variables:	Performance Pay	
Risk	-0.303* (0.205)	-0.381* (0.214)
Authority2	•	0.049 (0.473)
Authority3	•	0.185 (0.386)
Authority4	•	0.753** (0.424)
Firm Controls	YES	YES
Sample Size	1245	1245

Note: Results are estimated coefficients from probit models, with standard errors in parentheses. Firm controls are those listed in Table 3. * and ** denote statistical significance at the 10% and 5% levels, respectively, based on one-tailed tests.

TABLE 8: Testing the Main Prediction of Prendergast (2002)

	Dependent Variable:			
Independent Variables:	Performance Pay			
	(1)	(2)	(3)	(4)
Risk	-0.303* (0.204)	-0.376** (0.217)	-0.303*** (0.077)	-0.354* (0.217)
$AUTHORITY_{RANGE}(W)2$	•	0.081 (0.236)	•	0.752 (1.179)
$AUTHORITY_{RANGE}(W)3$	•	0.665*** (0.263)	•	0.954** (0.521)
Firm Controls	YES	YES	YES	YES
$\hat{\rho}$	0	0	0.095*** (0.038)	0.291 (0.517)
Sample Size	1245	1245	1245	1245
Log Likelihood	-1674.76	-1657.76	-1673.01	-1657.40

Note: Results are parameter estimates from a simultaneous-equations model in which the authority variables are treated as endogenous. Standard errors are in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively, based on one-tailed tests. Columns 1 and 2 impose $\rho = 0$, and columns 1 and 3 impose $\beta_2 = \beta_3 = 0$.

TABLE A1: Test of Prendergast's Main Prediction with Alternative Measures of Worker Authority

	Dependent Variable: Performance Pay					
Independent Variables:	(1)	(2)	(3)	(4)	(5)	(6)
Risk	-0.298* (0.205)	-0.369** (0.218)	-0.302* (0.208)	-0.358* (0.219)	-0.308* (0.202)	-0.368** (0.216)
$AUTHORITY_{RANGE}(W)2$	•	0.083 (0.237)	•	0.080 (0.232)	•	0.085 (0.232)
$AUTHORITY_{RANGE}(W)3$	•	0.671*** (0.264)	•	0.707*** (0.255)	•	0.709*** (0.257)
$AUTHORITY_{HOW}(W)2$	•	•	0.036 (0.533)	0.098 (0.582)	•	0.075 (0.582)
$AUTHORITY_{HOW}(W)3$	•	•	0.096 (0.518)	-0.037 (0.561)	•	-0.074 (0.559)
$AUTHORITY_{HOW}(F)2$	•	•	•	•	-0.157 (0.195)	-0.155 (0.187)
$AUTHORITY_{HOW}(F)3$	•	•	•	•	0.015 (0.199)	-0.081 (0.192)
Firm controls	YES	YES	YES	YES	YES	YES
Sample Size	1241	1241	1241	1241	1241	1241

Note: Results are estimated coefficients from probit models, with standard errors in parentheses. Firm controls are those listed in Table 3. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on one-tailed tests.

TABLE A2: Test of Prendergast's Main Prediction with Alternative Measures of Worker Authority

	Dependent Variable: Performance Pay in Largest Occupational Group					
Independent Variables:	(1)	(2)	(3)	(4)	(5)	(6)
Risk	-0.480**	-0.584***	-0.476**	-0.567***	-0.415**	-0.521**
	(0.245)	(0.244)	(0.246)	(0.240)	(0.233)	(0.241)
$AUTHORITY_{RANGE}(W)2$	•	0.553**	•	0.550**	•	0.548**
		(0.262)		(0.262)		(0.261)
$AUTHORITY_{RANGE}(W)3$	•	1.224***	•	1.307***	•	1.283***
		(0.287)		(0.299)		(0.306)
$AUTHORITY_{HOW}(W)2$	•	•	0.562*	0.342	•	0.407
			(0.431)	(0.385)		(0.426)
$AUTHORITY_{HOW}(W)3$	•	•	0.510	0.029	•	0.149
			(0.454)	(0.408)		(0.440)
$AUTHORITY_{HOW}(F)2$	•	•	•	•	0.476**	0.521**
					(0.270)	(0.252)
$AUTHORITY_{HOW}(F)3$	•	•	•	•	0.779***	0.651***
					(0.262)	(0.243)
Firm controls	YES	YES	YES	YES	YES	YES
Sample Size	1241	1241	1241	1241	1241	1241

Note: Results are coefficient estimates from probit models, with standard errors in parentheses. Firm controls are those listed in Table 3. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on one-tailed tests.